QUARTERLY TECHNICAL PROGRESS REPORT

FOR THE PERIOD ENDING

DECEMBER 31, 2000

For DOE Grant Entitled

"ENHANCED OIL RECOVERY WITH DOWNHOLE VIBRATION STIMULATION IN OSAGE COUNTY OKLAHOMA"

Contract Number:	**DE-FG26-00BC15191**
Contractor:	**Oil & Gas Consultants International, Inc. 4111 So. Darlington Suite 700 Tulsa, Oklahoma**
Contract Date:	**July 13, 2000**
Anticipated Completion:	**November 12, 2001**
Government Award:	**$430,000 (Current Year)**
Principal Investigators:	**J. Ford Brett Robert V. Westermark**
Project Manager:	**Virginia Weyland National Petroleum Technology Office**
Reporting Period:	**October 1, 2000 – December 31, 2000**

Disclaimer

Abstract

This Technical Quarterly Report is for the reporting period October 1, 2000 to December 31, 2000. The report provides details of the work done on the project entitled “Enhanced Oil Recovery with Downhole Vibration Stimulation in Osage County Oklahoma”.

The project is divided into nine separate tasks. Several of the tasks are being worked on simultaneously, while other tasks are dependent on earlier tasks being completed.

The selection of the pilot test area has been completed. The drilling of the test well is waiting on rig availability. Phillips has completed sonic core testing of offset cores, and is preparing a report of their findings. Design work is 80% complete for the field test version of the 7-inch tool, which will be built to fit the test well. Installation of monitoring equipment and the downhole vibration tool will occur after the well is drilled. Technical transfer efforts have begun with the writing of a technical paper SPE 67303 for the Society of Petroleum Engineers Production Operations Symposium in Oklahoma City meeting in March 24-27, 2001.

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Introduction

The objective of this project is to demonstrate the impact of downhole vibration stimulation on production rates in a mature waterflood field. Oil and Gas Consultants International, Inc. (OGCI) will manage the project in close cooperation with the Osage Tribe as the tests will be conducted in Osage County, Oklahoma, the mineral estate of the Osage Tribe. The field is owned and operated by Grand Resources, Inc. Phillips Petroleum Company will contribute their proprietary vibration core analysis of cores recovered from the pilot test area.

To achieve the project objectives, the work has been divided into nine tasks, some are concurrent, while other tasks rely on completion of previous steps. The initial task is a review of the available fields operated by Grand Resources, Inc. in Osage County Oklahoma to determine the appropriate pilot test area. Once the field is selected, Grand Resources, Inc., will maintain current field operations, collecting base-line production and injection data. The team will then determine where within the field to optimally locate the vibration test well. With the location determined, the test well will be drilled, cored, logged and 7" production casing run and cemented.

In a parallel effort, OGCI will be designing, building, and testing a new version of the downhole vibration tool based on their patented and field proven whirling orbital vibrator. With the field test tool built to run in 7" casing, duration testing of the downhole tool and surface power source will be conducted in nearby field operated by Grand Resources, Inc.

After the core is recovered, Phillips Petroleum Company will be conducting laboratory tests utilizing their proprietary sonic core apparatus to determine fluid flow response to a range of vibration frequencies. These results, in turn, will allow final adjustments to the frequency generation mechanisms of the downhole vibration tool.

An offset well, adjacent to the vibration test well, will be equipped with downhole geophones to determine strength of signal and if the producing formation has a characteristic resonant frequency response. Surface geophones will also be set out and arranged to pick up the signal generated by the downhole vibration tool.

The downhole vibrator will be installed in the test well. Monitoring the production and injection for the pilot test area will continue. As the frequency of the downhole tool is changed, the recording of seismic signals, both on the surface and downhole, will also be conducted. The results of the data collection will be a matrix of varying vibration stimulation conditions corresponding to changes in production fluid rates and seismic responses.

The report on the results of the downhole vibration stimulation will be prepared and delivered using several venues. Technical papers will be submitted to the Society of Petroleum Engineers and workshops are planned to be held for operators in Osage County and surrounding areas. A dedicated technical session on vibration stimulation may be offered at the 2002 SPE/DOE/IOR Conference, bringing together the world's experts in this emerging technology. The final task will be to close out the project.

Executive Summary

Contract Status:

There have been no changes to the contract during this reporting period.

Financial status:

During this quarter $75,314 has been dispersed with an additional $15,865 committed for work in progress.

Schedule Status:

The project schedule had slipped two months due to lack of drilling rig availability. The drilling delays have not yet had a major impact on the overall project schedule because other activities, which are on the project's critical path, are being conducted simultaneously.

However, there maybe further delays if the team decides to approach another operating company to move the field test location.

Technical Progress:

The Blazer Field was selected as the pilot test area. The location was determined and the well location built for the drilling of the Blazer Well # 18 A, in the autumn. However, high natural gas and oil prices caused a very tight rig market to develop in northeastern Oklahoma and the test well has not yet been drilled.

Phillips has conducted sonic core tests on samples from an existing "old" core from a well approximately five miles from the proposed pilot test area. Phillips has completed preliminary finding from tests on these "old" cores. The results are disappointing. There is very little change in the fluid flow characteristics through the core with or without vibration stimulation.

OGCI has completed 80% of the design work for the field version of the 7-inch downhole vibration tool (DHVT).

Experimental

SONIC CORE TESTING

Phillips has performed sonic core tests on the "old" offset cores obtained from the Oklahoma Geologic Survey. The results are of a preliminary nature, but they are disappointing. The cores are from the Bartlesville sandstone, a major producing horizon in northeast Oklahoma. The results of this preliminary sonic core testing will be provided in the following quarterly technical progress report.

The Bartlesville reservoir characteristics vary considerably throughout the area. The current theory on the depositional environment is an incised valley fill scenario. This has been proposed by Liangmiao[1] in a recently published thesis. The Blazer Field area, is on the edge of the ancient valley, which results in relatively poor quality reservoir characteristics. That fits well with the performance of the well. It also helps to explain the lack luster response to waterflooding. The Blazer field is on the poor end of the spectrum of Bartlesville producing fields in Osage county.

VIBRATION STIMULATION FIELD TESTING

The vibration stimulation well is scheduled to serve several functions during this test. Therefore the current plan is to change out downhole equipment several times during the field test. Initially the well will be completed conventional, perforated and a small fracture stimulation performed. The well will be rod pumped until a baseline is firmly established. Then the DHVT will be run in he well. Finally the well will be completed with both the DHVT and a reciprocating pump. Please refer to Figure 1 below for a schematic view of these steps. In Figure 2, there is a cut-away drawing of the DHVT. The DHVT will be held in the well much like a production packer. Slips will anchor the tool to the casing. This provides for a mechanical connection to transmit the vibration into the reservoir.

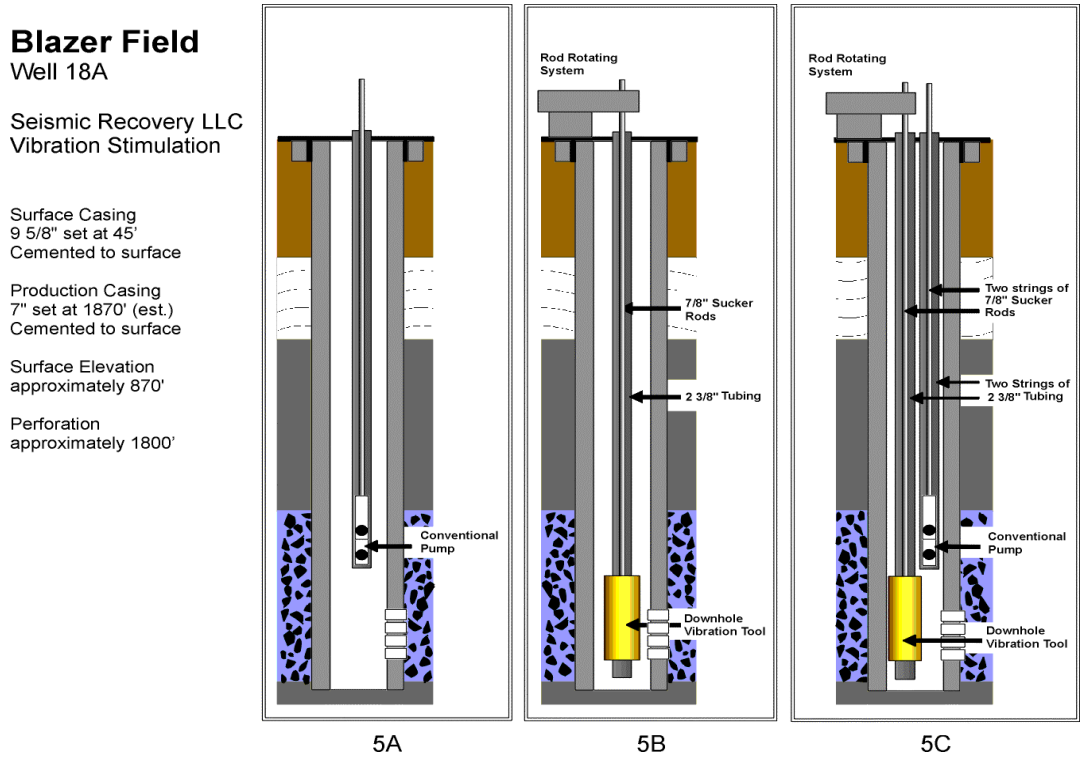

Figure 1 Proposed Completion Sequence for the Vibration Stimulation Well

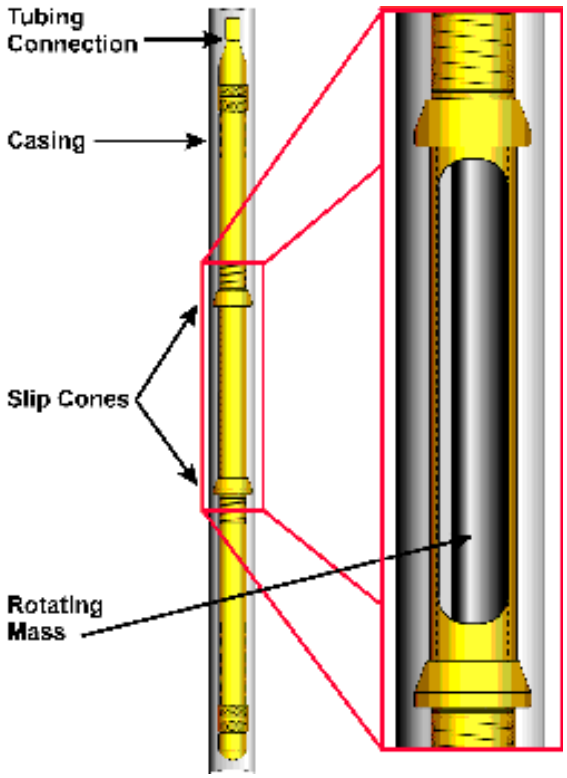

Figure 2 Cut-away sketch of Downhole Vibration Tool

Results and Discussion

THIS SECTION OF THE QUARTERLY REPORT REVIEWS IN DETAIL, THE PROGRESS MADE DURING THE QUARTER ON EACH OF THE PROJECT'S MAJOR TASKS AND SUB-TASKS.

TASK 1: DEFINE MOST APPROPRIATE TEST AREA

- *Meet as team to review field production history and scope possible locations.*

  SUB TASK COMPLETED.

- Review well logs, production records etc. and determine proposed test well location

  SUB TASK COMPLETED.

- *MEET TO DEFINE DRILLING LOCATION*

  SUB TASK COMPLETED.

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES OF PROJECT PLANS*

  SUB TASK COMPLETED.

TASK 1 MILESTONE: DEFINE TEST AREA

HAS BEEN ACCOMPLISHED

TASK 2 DRILL AND CORE TEST WELL

- *PREPARE THE WELL PLAN AND PERMIT THE WELL*

  SUB TASK COMPLETED.

- *BID THE DRILLING RIG AND SERVICES*

Drilling contractors were contacted and bids procured by Grand Resources, Inc. The recent up-turn in both oil and natural gas prices has produced a very tight rig market in northeastern Oklahoma. Two contractors have been short listed, based on anticipated availability of their rigs.

Bids for both surface and production casing have been received. Although, due to the delays in obtaining a drilling rig, the casing has not yet been purchased.

Bids for coring services have been received, but again due to the lack of a contracted drilling rig, the coring services have not been selected. The rig layout may dictate which coring equipment can be used and, hence, which coring service will be selected.

- *AWARD THE DRILLING AND SERVICE CONTRACTS*

The drilling contract and the related service contracts have not yet been let since the rig availability is still being negotiated.

- *PREPARE LOCATION*

  SUB TASK COMPLETED.

- *DRILL, CORE, AND CASE WELL*

This sub task has not yet been performed

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES OF PROJECT PROGRESS*

This sub task has not yet been performed.

TASK 3: DEFINE, CONDUCT & EVALUATE LAB TESTS

- *DEFINE SUITE OF LAB TESTS*

  SUB TASK COMPLETED.

- *REVIEW BARTLESVILLE SANDSTONE FIELD CHARACTERISTICS*

There have been numerous articles, papers and bulletins published on the Bartlesville Sandstone, a major producing formation in Osage County and all of northeastern Oklahoma. Some of the earliest work was done by the USGS. Bass[2] et al published several bulletins on Osage County in 1937. Many fields had been discovered and some experiencing declines in primary production back at that early date.

- *REVIEW OF LITERATURE*

Additional technical papers and thesis have been obtained concerning the emerging technology of elastic stimulation. Nikolaevskiy[3] et al. have reported a dominant frequency, much like a resonant frequency, which has been associated with elastic stimulation and improved oil recovery Yan Pan's[4] Ph.D. thesis "Reservoir Analysis Using Intermediate Frequency Excitation," has very interesting theoretical implication concerning the dominant frequency concept, which in essence suggests that a reservoir acts as a system and will respond to discrete ranges of frequencies of vibrations based on it's solid and fluid properties.

- *ANALYZE THE OFFSET CORE*

  SUB TASK COMPLETED.

- *CONDUCT LAB TESTS ON "OLD" OFFSET CORES*

To avoid delaying the project, the team was able to obtain for Phillips, samples from an existing "old" core from a well approximately five miles from the proposed pilot test area. Phillips has completed preliminary finding from tests on these "old" cores. The results are disappointing. There is very little change in the fluid flow characteristics through the core with or without vibration stimulation. Please refer to "*SONIC CORE TESTING*" above for details concerning the sonic core tests performed.

WORK ON THESE SUBTASKS HAS NOT COMMENCED.

- *EVALUATE LAB TEST RESULTS FOR FREQUENCY AND AMPLITUDE*
- *MEET TO REVIEW LAB TEST RESULTS & BRACKET FIELD TEST FREQUENCIES/AMPLITUDES*
- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

TASK 4: DESIGN AND CONSTRUCT DOWN HOLE VIBRATION TOOL AND SURFACE POWER SOURCE

- *FRONT END SOURCE ENGINEERING - SELECT MOST APPROPRIATE POWER SOURCE*

  SUB TASK COMPLETED.

- *ENGINEER SOURCES TO SPECIFICATIONS*

An engineering review of the prototype tool has been completed. It thoroughly considers the load and stresses generated when backwards whirling occurs. This report has been used to finish the design the 7-inch field version of the DHVT.

- *CONSTRUCT TOOL(S) & SOURCES*

The field test tool has been designed to use many 'off the shelf' items from downhole tool manufacturers including the housing and slip mechanisms. Taking the equations from the prototype design review, the stresses and anticipated loads have been determined for the 7-inch DHVT.

Machine drawings are 80% complete. When all material has been procured, machining will begin this is anticipated to occur in February 2001.

- *SURFACE TEST TOOLS*

Well selection is complete for to conduct the surface testing of the field test tool in conjunction with the power source life testing at the Bird Creek Field, a field operated by Grand Resources, Inc., just north of Tulsa, west of highway US 75.

- *CONDUCT POWER SOURCE LIFE TEST*

The potential to coordinate field work with the geophysical equipment from Lawrence Berkeley National Lab (LBNL) is possible if the "listening" to the 7-inch DHVT could be done while a team from LBNL is working at the University of Arkansas field test site outside Fayetteville AR.

This would combine the surface test with the power source tests at Bird Creek Field (see above paragraph). Discussions have been held with Las Alamos National Lab and Lawrence Berkeley National Lab to provide both equipment and personnel to help set and monitor the seismic signal generated during the surface testing.

- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

This sub task has not yet been performed.

TASK 5: INSTRUMENT TEST WELLS

- *ENGINEER SEISMIC MEASUREMENT SYSTEM*

Discussions have occurred with Ernie Majors, at LBNL concerning the possibility of utilizing their equipment and services to monitor both surface and downhole geophysical responses to the downhole vibration stimulation. As mentioned above, that the during the source life testing subtask, may be an appropriate time to gather seismic response data as well as during the production stimulation phase .

WORK ON THE FOLLOWING SUB TASKS HAS NOT COMMENCED.

- *SPECIFY SEISMIC MEASUREMENT SYSTEM*

- *INSTALL SEISMIC MEASUREMENT SYSTEM*
- *REPORT TO OSAGE TRIBAL REPRESENTATIVES ON PROJECT PROGRESS*

TASK 6: CONDUCT FIELD VIBRATION STIMULATION TESTS

WORK ON THIS TASK HAS NOT COMMENCED.

TASK 7: REPORT FIELD TEST RESULTS

WORK ON THIS TASK HAS NOT COMMENCED.

TASK 8: TECHNOLOGY TRANSFER, PUBLICIZE TEST RESULTS

- *WRITE & SUBMIT SPE PAPER ABSTRACT*

The abstract, “Enhanced Oil Recovery with Downhole Vibration”, for the March 24, 2001 SPE Production Operation Symposium in Oklahoma City was accepted.

- *AUTHOR SPE PAPER*

The final version of SPE 67303 “Enhanced Oil Recovery with Downhole Vibration” is being routed through the NPTO contract officer and Phillips prior to being sent to SPE.

WORK ON THE SUBTASKS LISTED BELOW HAS NOT COMMENCED.

- *PREPARE VIBRATION ENHANCED PRODUCTION WORKSHOP*
- *PUBLICIZE VIBRATION ENHANCED PRODUCTION WORKSHOP - PTTC, OIPA, BIA,*
- *CONDUCT BIA, TRIBAL COUNCIL AND OSAGE COUNTY OPERATORS VIBRATION ENHANCED PRODUCTION WORKSHOP DATE TBD*
- *CONDUCT DOE/IOR/SPE CONFERENCE VIBRATION ENHANCED PRODUCTION WORKSHOP DATE TBD*
- *CONDUCT PTTC OK CITY VIBRATION STIMULATION WORKSHOP*
- *CONDUCT PTTC /U OF KANSAS VIBRATION ENHANCED PRODUCTION WORKSHOP DATE TBD*
- *AUTHOR DOE CONFERENCE PRESENTATION DATE TBD*
- *PRESENT DOE CONFERENCE PAPER DATE TBD*
- *PRESENT DOE/BIA CONFERENCE PAPER DATE TBD*

TASK 9: FINISH AND CLOSE OUT PROJECT

WORK ON THIS TASK HAS NOT COMMENCED.

Conclusions

Project Management

The drilling of the test well has delayed the project approximately two months. Other tasks which are independent of the drilling schedule, are on schedule.

Technical Issues

The drilling has been delayed due to problems with drilling rig availability.

To avoid delaying the project, the team was able to obtain for Phillips, samples from an existing “old” core from a well approximately five miles from the proposed pilot test area. Phillips has completed preliminary finding from tests on these “old” cores. The results are disappointing. There is very little change in the fluid flow characteristics through the core with or without vibration stimulation.

An engineering review of the prototype tool has been completed. Its design thoroughly considers the load and stresses generated when backwards whirling occurs. This report has been used to finish the design the 7-inch field version of the DHVT. The 7-inch DHVT is 80% designed.

References

1. Liangmiao, Y. et al.: "Sequence Stratigraphy of the Middle Pennsylvanian Bartlesville Sandstone, Northeastern Oklahoma: A Case of an Underfilled Incised Valley," American Association Petroleum Geologists Bulletin, Vol. 84 No.8 (August 2000) 1185.
2. Bass, N. W. et al.: *Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma*, United States Department of the Interior, Geologic Survey Bulletin 900, United States Government Printing Office, Washington D. C. (1942)
3. Nikolaevskiy, V.N. et al.: "Residual Oil Reservoir Recovery With Seismic Vibrations," SPE Production & Facilities, (May 1996) 89.
4. Pan, Y., “Reservoir Analysis Using Intermediate Frequency Excitation,” presented as a dissertation for the Degree of Doctor of Philosophy, Stanford University (August 1999).